

Introduction to Plant Disease



Review of Principles

What is a disease?

Any abnormal condition that damages a plant and reduces its productivity or usefulness to man.

Two types of diseases.

1. **Non-infectious** (abiotic)

- ◆ Not caused by a living parasitic organism; usually an environmental factor

2. **Infectious** (biotic)

- ◆ Caused by a living parasitic organism

What is a non-infectious disease?

-- Diseases caused by some environmental factor that produces an abnormal plant, abnormal appearance.

Examples:

- ◆ **Nutrition.** Excess or deficiency
 - N deficiency, yellowing
- ◆ **Moisture.** Deficient or excessive water.
 - Deficiency, stunting
 - Excessive, lack of oxygen to roots.

What is a non-infectious disease?

More examples:

- ◆ **Temperature.** Cold or hot.
 - Frost damage; heat sterility in small grains.
- ◆ **Meteorological conditions.**
 - Sun, sunscald.
 - Heat canker caused by high temperature
- ◆ **Toxic chemicals.**
 - Ozone injury; Salt injury.

What is an infectious disease?

Infectious (biotic) diseases are caused by organisms that attack plants and get their nutrition from them.

- ◆ **Host** - the plant attacked by a parasite.
- ◆ **Pathogen** - the organism causing the disease.
 - **Fungi; Bacteria; Viruses; Mycoplasmas; Nematodes**

Terms

- ◆ **Parasite** - an organism living on or in another living organism and obtaining food from another organism.
- ◆ **Obligate parasite** - always a parasite; can only live on or in another organism.
 - ❖ Parasites causing leaf rust, stem rust of cereals.
- ◆ **Facultative parasite** - having the ability to be a parasite; can live on living or non-living host.
 - ❖ Parasites causing leaf spots of cereals.

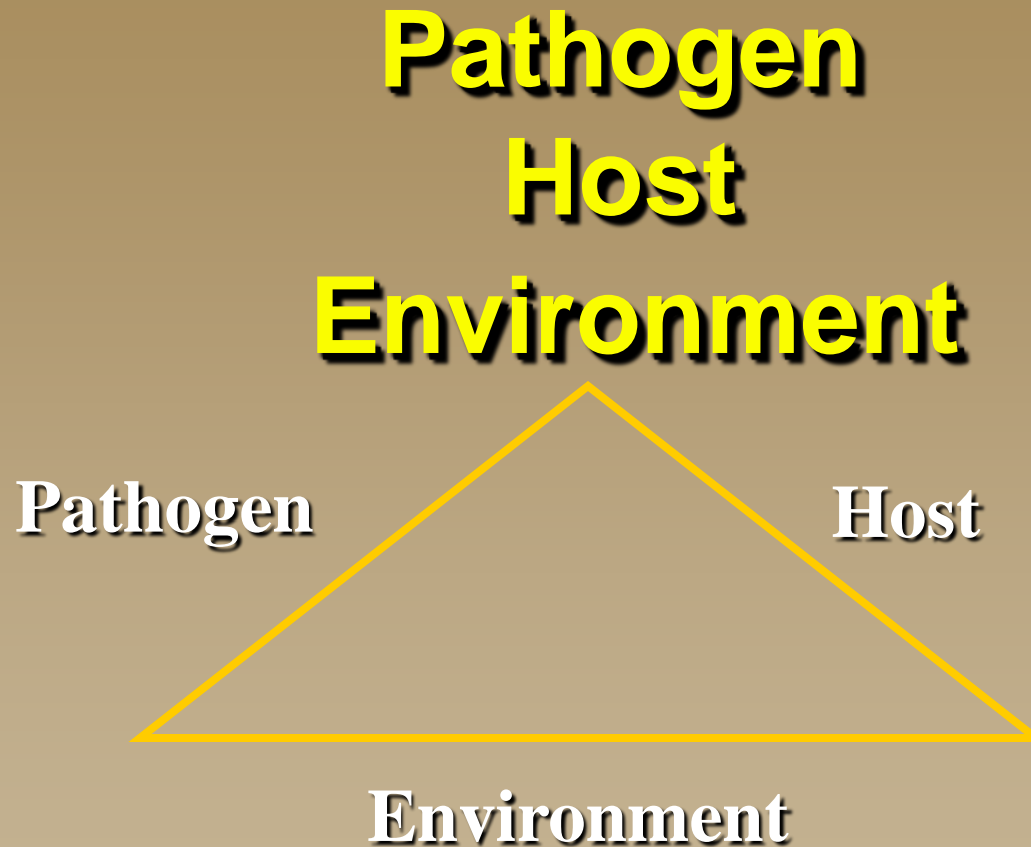
Terms

- ◆ **Symptoms** - expressions of plant diseases; visible abnormalities; tissue death; stunting; abnormal color
 - **Necrotic** - dead and discolored.
 - **Chlorosis** - yellowing of normally green tissue
- ◆ **Signs** - presence of pathogen or its parts
 - fungal structures; bacterial ooze

Terms

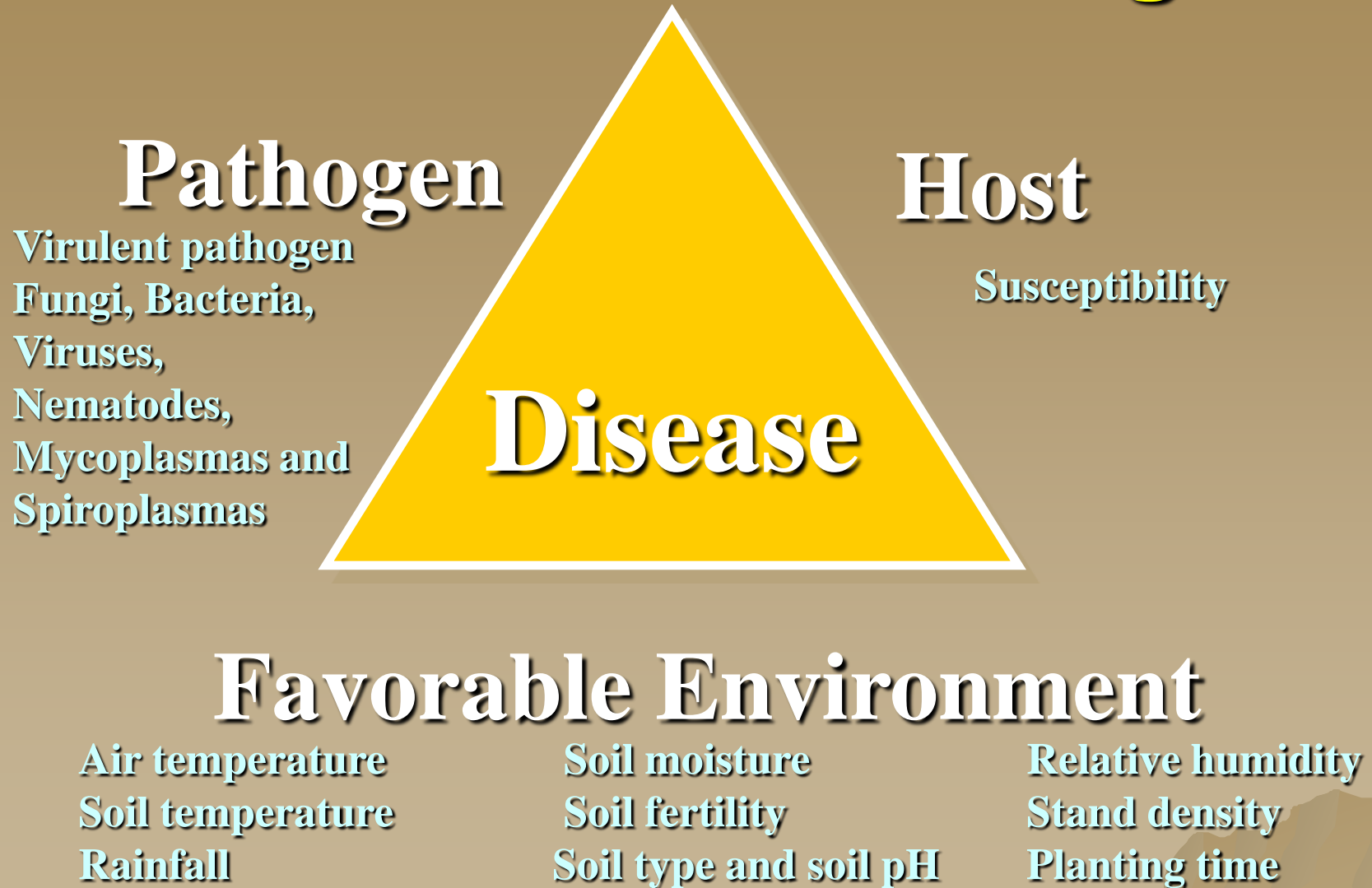
- ◆ **Inoculum** - pathogen or its parts that can cause infection. That portion of the pathogen brought into contact with the host.
 - Spores; mycelial fragments or structures
- ◆ **Predispose** - weaken plants; increase effects of infectious diseases.
 - Temperature, moisture, wind, light, soil pH, nutrition, herbicides

Three factors needed to produce a disease:



If any of the 3 factors is missing disease will not develop.

Plant Disease Triangle



Pathogen

The organism causing the disease

- ◆ **Fungus, fungi** - organisms which lack chlorophyll and range in form from a single cell to a body mass of branched filamentous hyphae. Includes the yeasts, molds, smuts, and mushrooms.
- ◆ Hyphae, **mycelium**, thread-like filaments.
- ◆ **Fruiting bodies**, structures containing spores; can be signs on the host.
- ◆ **Spores**, reproductive unit; seeds;
- ◆ E.g. Rusts, smuts, leafspots, powdery mildew

Pathogen

- ◆ **Bacterium, bacteria** - microscopic single-celled organisms; reproduction by division of body into two parts.
 - Bacterial blights, wilts, fireblight
- ◆ **Viruses** - submicroscopic particles of RNA with a protein coat; obligate parasite.
 - Wheat streak mosaic, cucumber mosaic, potato viruses

Pathogen

- ◆ **Nematodes** - generally microscopic eelworms or roundworms
 - ❖ Usually not a serious problem in North Dakota
 - ❖ Carriers or vectors of viruses, fungi, or bacteria.
- ◆ **Mycoplasmas** - microorganisms with no cell wall, no definite shape.
 - ❖ Aster yellows (purple top in potato and tomato).

Environmental Factors

- ◆ **Once disease established, local environment determines rate of disease development**
 - Disease severity can differ from site to site or be similar in region
 - ◆ **Rainfall**
 - Risk of disease greatest with highest rainfall levels
 - Dry conditions or intermittent wet/dry can limit disease development
 - ◆ **Temperature can influence disease**
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Knowledge of Crop Diseases

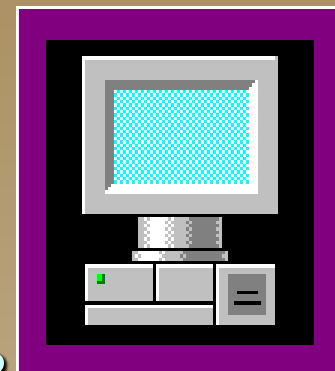
Important for developing management tactics

- ◆ Major crop diseases on crop grown?
- ◆ Host range of major plant pathogens?
- ◆ Major crop diseases in your area?

Records of Crop Diseases

Important for developing management tactics

- ◆ Local farm and field history?
 - Disease problems in past?
 - ◆ Crop sequence in fields?
 - No. of years since last host crop?
 - Disease impact in last host crop?
 - ◆ Field scouting/In-crop inspections
 - Diseases present; disease impact
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Measurement of Disease

- ◆ **Incidence of disease** - proportion of host units that show symptoms.
- ◆ **Severity of disease** - proportion of area or amount of plant tissue that is diseased; percentage of plant destroyed by disease.
- ◆ **Yield loss** - proportion of yield that grower will not harvest because of disease.

General disease cycle

- ◆ **Monocyclic or single cycle pathogens** - one disease cycle in one year. e.g. Smuts
- ◆ **Polycyclic or multi-cycle pathogens** - more than one cycle per year; secondary inoculum, secondary infection. e.g. Downy mildews, powdery mildews, grain rusts, leaf spots

Pathogen Factor

- ◆ **How are pathogens transmitted?**
 - Air-borne, long distance (rusts)
 - Air-borne, short distance
 - Seed-borne (smuts)
 - Insect transmitted (WSMV)
 - ◆ **How do pathogens survive?**
 - Stubble or residue borne
 - Seed-borne
 - Soil-borne
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-

Dissemination (spread) of pathogens

- ◆ **Wind** - Air-borne fungal spores
 - Wheat leaf rust, stem rust
- ◆ **Insects** - Carriers of viruses
 - Aphids - barley yellow dwarf
- ◆ **Water** - Carry or splash spores
- ◆ **People** - Carry over long distances
 - e.g. contaminated farm equipment
- ◆ **Animals and birds**

Survival of pathogens

◆ Soil

- Resistant structures of pathogens, e.g. sclerotia

◆ Seed and plant parts

- Pathogens survive in infected seed and plant parts

◆ Insects

- e.g. Bacterial wilt pathogen in cucumber beetles

◆ Mild climates

Basic methods of plant disease management.

- ◆ **Exclusion** of pathogens
- ◆ **Eradication** or elimination of pathogens
- ◆ **Host Resistance**
- ◆ **Protection**

Protect plants from infection

Basic methods of plant disease management.

- ◆ **Exclusion** of pathogens.
 - Quarantine.
 - Seed certification for low levels of pathogens.
 - Indexing, testing for pathogens, e.g.. viruses
- ◆ **Eradication** or elimination of pathogens.
 - **Crop rotations** keep populations low.
 - Eradication of alternative hosts.
 - Sanitation, removal of inoculum

Crop Rotation a key factor



- ◆ Similar crops usually have similar diseases
- ◆ Disease severity and yield losses are higher with crop monoculture

Basic methods of plant disease management

- ◆ **Host Resistance.** Two types
 - **General resistance.** (Horizontal resistance)
 - Slows down disease development.
 - Stable against all races of pathogen.
 - **Specific resistance.** (Race specific)
 - High level; may fail with new race.
- ◆ **Tolerance.** Ability of plant to sustain disease without dying or suffering loss

Resistant Host – No Disease

“Plant Disease Triangle”

Pathogen

Non-Host
or
Resistant
Crop

No

Disease

Favorable Environment

Basic methods of plant disease management.

- ◆ **Protection.** Protect plants from infection.
 - Cultural practices.
 - ◆ Time of planting; Destruction of volunteers
 - Handling practices.
 - ◆ Mature potato tubers less prone to infection by late blight fungus.
 - Managing insect vectors.
 - ◆ Weed management
 - Fungicides.

Fungicides

-- Protectant fungicides --

Protect plants from infection

- Act on plant surface to protect against infection.
- Timely application is critical.
- Cannot stop development of a pathogen once the infection occurs.

Fungicides

-- Systemic fungicides --

- Taken up (absorbed) by plant tissues and then function to prevent infection.
- Protect both sides of leaf; Not washed off; Not decomposed by sunlight.

Seed Treatments

- **Control soil-borne pathogens**
 - Root rots, damping-off, seedling blights
- **Control surface-borne pathogens**
 - Safflower rust
- **Control internally-borne pathogens**
 - Loose smut fungi of cereals.

Smut Stopped with Seed Treatment

“Plant Disease Triangle”

**Pathogen
Eliminated
with
Fungicide**

Host

No

Disease

Favorable Environment

Consider before fungicide use.

- ◆ Field disease history - past diseases
- ◆ Disease severity - amount of damage
- ◆ Growth stage - efficacy of fungicide
- ◆ Weather/disease interaction
 - disease potential
- ◆ Fungicide selection
- ◆ Application method
- ◆ Potential economic return

Fungicides

Always follow label directions.

- ❖ Your intended use must be consistent with the label.
- ❖ Check instructions on how and when to apply.
- ❖ Check waiting periods before harvest.
- ❖ Check important safety precautions.

Principles of Integrated Pest Management (IPM).

- ◆ Whenever possible, **eradication, exclusion, host resistance, and protection** should be practiced.
- ◆ The use of these combined practices usually produce the most reliable and stable plant disease management.
- ◆ Growers need to integrate as many different management tools as possible for long term success.

Factors to recognize in disease management programs.

- ◆ Field history - past diseases
- ◆ Crop sequence - non-host crop
- ◆ Variety selection - resistance
- ◆ Seed/plant source - inoculum free
- ◆ Site preparation - improve plant growth
- ◆ Planting date - avoid certain weather patterns; vary planting time

Factors to recognize in disease management programs.

- ◆ Plant density – microenvironment
- ◆ Nutrients - balanced, reduce stress
- ◆ Water management - irrigation
- ◆ Weed control - sources of inoculum
- ◆ Timeliness of harvest - avoid inoculum on seed
- ◆ Sanitation - reduce inoculum, clean equipment.

Review

- ◆ 1. What are the three factors necessary for the development of a disease?
- ◆ 2. Difference between the severity and incidence of a disease?
- ◆ 3. A process by which a pathogen establishes a parasitic relationship?
a. dissemination, b. inoculation, c. infection
- ◆ 4. What does IPM stand for?

Review

- ◆ 5. Two types of host resistance?
- ◆ 6. What are the four main components of integrated pest management?
- ◆ 7. What is inoculum?
- ◆ 8. What are the three most important types of pathogens in ND? a. Fungi, b. Bacteria, Nematodes, c. Mycoplasmas, d. Viruses
- ◆ 9. What is a monocyclic or single cycle pathogen?

Review

- ◆ 10. Would it be easier to control a monocyclic or polycyclic pathogen?
- ◆ 11. Difference between systemic and non-systemic fungicide?
- ◆ 12. Why is crop rotation important for managing diseases?

**Additional information is available on
internet links, check out
“Internet Links for Information on Plant Diseases”
provided on the
Crop Sequence Calculator**

Also available:

Managing Plant Disease Risk in Diversified Cropping Systems.

Krupinsky, J.M., K.L. Bailey, M.P. McMullen, B.D. Gossen, and T. Kelly Turkington
2002, *Agronomy J.* 94:198-209.